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# Indian Standard

# SPECIFICATION FOR LEAD-ACID TRACTION BATTERIES

## ( First Revision )

First Reprint NOVEMBER 1989

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**BUREAU OF INDIAN STANDARDS**
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4

*April* 1981

# *Indian Standard*

# SPECIFICATION FOR LEAD-ACID TRACTION BATTERIES

## *( First Revision )*

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( *Continued on page* 2 )

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# *Indian Standard*

# SPECIFICATION FOR LEAD-ACID TRACTION BATTERIES

## *( First Revision )*

## 0. FOREWORD

**0.1** This Indian Standard ( First Revision ) was adopted by the Indian Standards Institution on 28 November 1980, after the draft finalized by the Secondary Cells and Batteries Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** This standard was originally issued in 1969. This revision has been prepared to take into account recent application and developments in the field of traction cells. An appendix on guidelines on design of battery trays and layouts has also been incorporated for guidance on battery tray construction and layouts.

**0.3** In oder to promote export of these cells the heights of cells have not been standardized.

**0.4** In the preparation of this standard, assistance has been derived from the following publications:

IEC Publication 254-1967 Lead-acid traction batteries. International Electrotechnical Commission.

BS : 2550-1971 Specification for lead-acid traction batteries for battery electric vehicles and trucks. British Standards Institution.

**0.5** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Rules for rounding off numerical values ( *revised* ).

## 1. SCOPE

**1.1** This standard lays down dimensions, performance requirements and methods of test for traction cells and batteries for the power supply to electric traction vehicles and industrial trucks.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the definitions given in IS : 1885 (Part VIII)-1970* in addition to the following shall apply.

**2.1 Traction Cell** — Cell intended to be used for the power supply to an electric traction vehicle or industrial truck.

**2.2 Industrial Truck** — A battery powered vehicle intended for mechanical handling of items and not for use on public roads. The principal types are platform trucks, pallet trucks, fork-lift trucks and reach trucks.

**2.3 Cover** — A removable or hinged covering of wood, metal or suitable material enclosing the top of the battery unit when accommodated in a tray.

**2.4 Tray** — An outer container of wood, metal or suitable material to accommodate the battery unit.

**2.5 Lug-Type Terminal** — A terminal having a flat surface with one or more hole(s) for bolt(s) for connection to another battery unit or external circuit.

**2.6 Tapered Cable Thimble** — A device fitted to the end of a flexible cable to form a connection between the cable and the battery unit.

**2.7 Thimble Socket** — A fitting which forms the connection between the end terminal post and tapered cable thimble.

**2.8 Tightening Screw** — A screw used for securing the tapered cable thimble to the thimble socket.

**2.9 Type Tests** — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general quality and design of a given type of cell.

**2.10 Acceptance Tests** — Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot.

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*Electrotechnical vocabulary: Part VIII Secondary cells and batteries.

**2.10.1** *Lot* — All cells of the same type, design and rating, manufactured by the same factory during the same period, using the same process and material offered for inspection at a time shall constitute a lot.

**2.11 Routine Test** — Tests carried out on every cell.

## 3. MATERIALS AND CONSTRUCTIONAL REQUIREMENTS

**3.1 Assembly** — The complete battery as fitted to a vehicle shall consist of one or more self-contained units connected in series or parallel as necessary. Each unit shall consist of a number of individual cells assembled into a tray.

**3.2 Containers** — The elements of an individual cell shall be assembled in a cell box and fitted with a lid with vent plug. Containers and lids shall be of rubber, plastics or other suitable material. If the containers are of rubber or plastics, they shall conform to IS : 1146-1972*.

**3.3 Venting Device** — The venting device shall be of anti-splash type and shall allow the gases to escape freely but shall effectively prevent acid particles or spray from coming out. Provision shall be made for drawing electrolyte samples, checking and servicing of the electrolyte.

**3.4 Sealing** — The arrangements for sealing between the lid and the cell box, and between the terminal posts and the lid, shall be such as to prevent any leakage of electrolyte in service. Sealing compound, if bitumen based, shall conform to IS : 3116-1965†.

**3.5 Trays** The material of tray, whether wood, metal or other suitable material, shall be adequately protected against deterioration caused either by the action of sulphuric acid or other conditions arising from normal usage. The trays shall be provided with lifting arrangements which shall be suitably protected against corrosion ( *see* Appendix A ).

**3.6 Covers** — Where covers are used, adequate protection against corrosion, as for trays, shall be made. They shall be so designed and fitted as to minimise ingress of foreign matter without unduly restricting ventilation, and shall be capable of easy removal.

**3.7 Cell Connectors** — Intercell connectors shall be either burned or bolted to terminal posts. Connectors shall be either of lead, or suitably

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*Specification for rubber and plastic containers for lead-acid storage batteries ( *first revision* ).

†Specification for sealing compound for lead-acid batteries.

coated copper or aluminium or of insulated copper or aluminium cored cable. The coating for copper and aluminium connectors shall be adequate and tenacious.

**3.8 Connections** — The connections from the end terminals of each unit to the adjacent unit or to the external circuit shall be made of flexible insulated cable. The fittings on the cable shall be suitable for the type of termination fitted to the cells.

**3.9 End-Terminal Posts and Connectors** — End-terminal posts shall be fitted with a thimble-socket or lug-type terminal as shown in Fig. 1 to 5.

**3.9.1** The tapered cable thimbles shall be of brass and lead plated to a thickness of not less than 0·06 mm. The dimensions of the positive thimble shall conform to Fig. 3A. The negative thimble shall conform to Fig. 3B except that it shall be permissible, by agreement between the manufacturer and the purchaser, to omit the hexagonal portion of the positive and negative cable thimbles, provided that the dimensions in other respects conform to those shown in Fig. 3A and 3B.

**3.9.2** The positive cable thimble shall be identified by a 1·3 mm wide groove round the tapered end as shown in Fig. 3A.

**3.9.3** Tightening screws shall conform to the dimensions shown in Fig. 4.

**3.10 Electrolyte** — The battery grade sulphuric acid conforming to IS : 266-1961* shall be used for the preparation of the electrolyte.

**3.11 Water** — Water conforming to IS: 1069-1964† shall be used in the preparation of electrolyte and to bring the electrolyte level to approximately the correct height during the course of testing and operation.

## 4. RATINGS

**4.1 Rated Capacity** — The rated capacity C5 assigned to the cell or battery by the manufacturer shall be the capacity expressed in ampere-hours ( after correction to 30°C ) obtainable when the battery or cell is discharged at the 5-hour rate to a final voltage of 1·70 V per cell under conditions of test specified in **7.10**.

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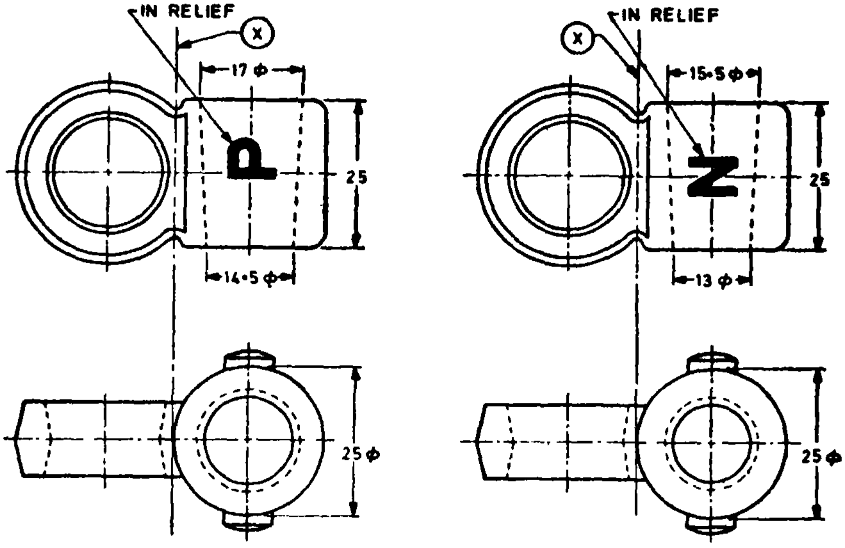
*Specification for sulphuric acid ( *revised* ).

†Specification for water for storage batteries ( *revised* ).

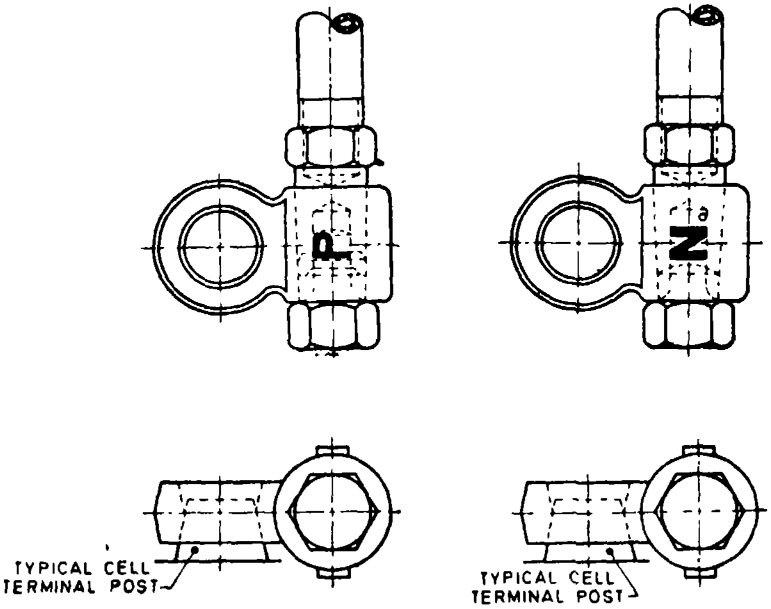


**1A Positive** **1B Negative**

*X* = Parts of thimble socket to the *left* of this line may be designed to suit manufacturer's terminal post.

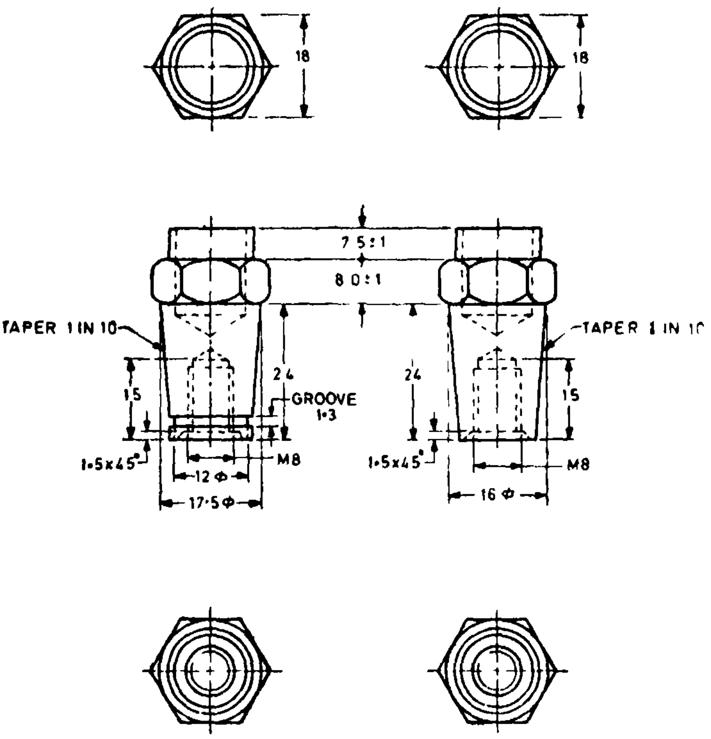
All dimensions in millimetres.

Fig. 1 Thimble Sockets



**2A Positive** **2B Negative**

Fig. 2 Assembly



3A Positive 3B Negative

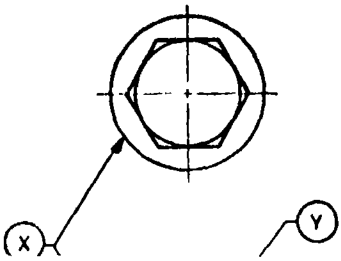
All dimensions in millimetres

FIG. 3 TAPERED CONE THIMBLE

**4.2 Nominal Voltage** — The following shall be the preferred nominal voltages of the traction batteries:

12, 24, 30, 36, 48, 72 and 80 V.

NOTE — Voltages other than those mentioned above shall be subject to agreement between the manufacturer and the purchaser.

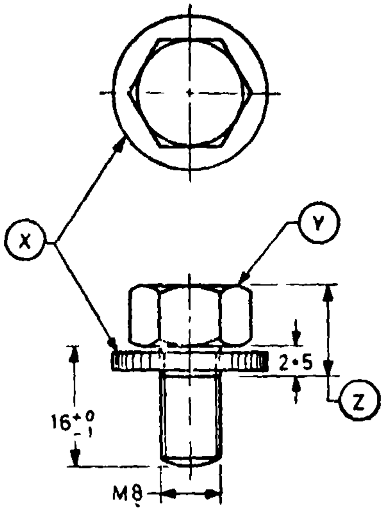


# AMENDMENT NO. 2 JANUARY 1985
# TO
# IS:5154-1980 SPECIFICATION FOR LEAD-ACID TRACTION BATTERIES
## *(First Revision)*

(*Page 9, clause 5.2, line 2*) - Substitute '± 6 mm' *for* '±5 mm'.

(ETDC 11)

Reprography Unit, BIS, New Delhi, India



Material — Mild steel

X — Machine washer M8 IS : 2016 M.S. lead plated,

Y — 8 mm bolt maximum width across flats with corners chamfered both sides = 13, and

Z — Portion of M.S. to be lead plated

All dimensions in millimetres

FIG. 4 M.S. TIGHTENING SCREW

## 5. DIMENSIONS OF CELLS

**5.1 Cell Width** — The recommended width of cells shall be one of the following:

160 ± 5 mm, 200 ± 5 mm

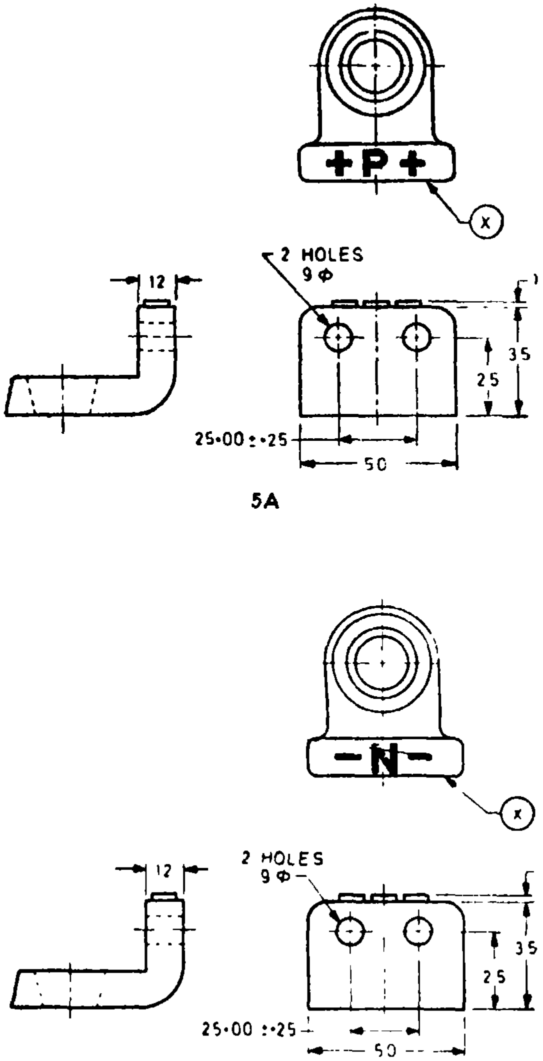
**5.2 Cell Lengths** — The following shall be the recommended cell lengths with a tolerance of ± 5 mm:

*For 160 mm width cells*

*Length*, mm — 50, 65, 80, 95, 110, 130, 145, 163, 179, 192, 208, 225, 240, 255, and 270.

*For 200 mm width cells*

Under consideration ( since batteries with 200 mm width are currently not being manufactured ).



5A

5B

*X* = Face to be parallel to longitudinal axis of the battery.

All dimensions in millimetres.

FIG. 5 LUG TYPE TERMINATION

# AMENDMENT NO. 1 DECEMBER 1982
# TO
# IS : 5154-1980 SPECIFICATION FOR LEAD-ACID TRACTION BATTERIES

## *( First Revision )*

### Addenda

[ *Page* 11, *clause* **7.1.1.1**(e) ] — Add the following new matter after (e):

| | *Cell Number* | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 'f) Life test ( **7.11** ) | — | — | X | X |

( *Page* 14, *clause* **7.10.7** ) — Add the following new clauses after **7.10.7**:

'**7.11 Life Test** — The life test shall be carried out on cells which have satisfied the requirement of **7.10**.

**7.11.1** The cells shall be fully charged in accordance with the manufacturers instructions and the level and specific gravity of the electrolyte in each shall be checked and, if necessary, adjusted ( *see* **7.4** ).

**7.11.2** The cells shall then be subjected to a series of successive discharges and charges, the recharge following immediately after the discharge. Each cycle of discharge and charge shall consist of:

a) discharge for 3 hours at a current of $I = 0{\cdot}25\ C5$ A, and

b) charge for 9 hours at an average current of $I = 0{\cdot}096\ C5$ A.

**7.11.3** The life test shall be continued at the rate of two cycles per day.

**7.11.4** After each series of 50 cycles, the capacity of the cells shall be checked in accordance with **7.10**, after a full recharge. After the capacity check, the cells shall be fully charged and the cycle of discharge and charge shall be resumed.

**7.11.5** Throughout the life test, the temperature of electrolyte shall be maintained between 33°C and 43°C.

**7.11.6** Throughout the life test, the level of electrolyte in the cells shall be maintained at the level specified by the manufacturer by periodic topping up with distilled water.

**7.11.7** The life test shall be terminated when the capacity of a cell or battery on a test discharge ( *see* **7.11.4** ) falls to 80 percent of the rated capacity.

**7.11.8** *Requirement* — The total number of discharges ( including test discharges ) shall be not less than 1 000 before the capacity of the cells falls to 80 percent of their rated capacity. '

( ETDC 11 )

## 6. MARKING

**6.1** Trays shall be clearly and permanently marked with the information given under (a) to (c). The information given under (d) shall be marked on each cell:

a) Manufacturer's name and/or trade-mark,
b) The nominal voltage and rated capacity of the battery,
c) Country of origin, and
d) Month and year of manufacture.

**6.1.1** The following information shall be given on the instruction cards supplied with the cells or batteries:

a) Instructions for filling and first charging of the cell, and
b) Maintenance instructions including charging rates.

**6.2** The cells and batteries may also be marked with the ISI Certification Mark

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution ( Certification Marks ) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturer or processor, may be obtained from the Indian Standards Institution.

## 7. TESTS

### 7.1 Classification of Test

**7.1.1** *Type Tests* — The tests specified in **7.1.1.1** shall constitute the type tests.

**7.1.1.1** *Sequence of tests and samples* — Four samples of cells shall be drawn at random by the testing or inspecting authority. The sequence of tests shall be as indicated in the schedule below:

| *Tests* | *Cell Number* | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| a) Visual examination ( **7.6** ) | × | × | × | × |
| b) Checking of dimensions ( **7.7** ) | × | × | × | × |
| c) Test for materials and components ( **7.8** ) | × | × | × | × |
| d) Air pressure test ( **7.9** ) | × | × | × | × |
| e) Test for capacity ( **7.10** ) | × | × | × | × |

**7.1.1.2** If any of the samples fail in the relevant type test, the testing or inspecting authority may call fresh samples not exceeding twice the original number and subject them again to the test(s) in which failure occurred. If there is any failure in the retest(s), the type shall be considered as not complying with this standard.

**7.1.2** *Acceptance Tests* — The following shall constitute the acceptance tests:

a) Visual examination ( **7.6** ),
b) Checking of dimensions ( **7.7** ),
c) Air pressure test ( **7.9** ), and
d) Test for capacity ( **7.10** ).

**7.1.2.1** *Sampling scheme and criteria for acceptance* — The sampling scheme and criteria for acceptance of a lot shall be in accordance with **5.1.4** of IS : 8320-1976*.

**7.1.3** The following shall constitute the routine tests:

a) Visual examination ( **7.6** ), and
b) Air pressure test ( **7.9** ).

**7.2 Equipment for Tests** — The voltmeters, ammeters, thermometers and hydrometers used for the tests shall comply with the requirements of **5.2** of IS : 8320-1976*.

**7.3 Temperature for Tests** — Unless otherwise specified, the temperature of electrolyte during test discharge shall be within the limits of 20°C and 35°C.

**7.4 Specific Gravity** — For the purpose of test requirements, the specific gravity of a fully charged cell, corrected to 30°C, shall be $1{\cdot}280 \pm 0{\cdot}005$.

**7.4.1** To correct the specific gravity reading to 30°C, the following formula shall be used:

$$SG_{30} = SG_t + 0{\cdot}0007\,(t - 30)$$

where

$SG_{30}$ = specific gravity at 30°C,
$SG_t$ = specific gravity at $t$°C, and
$t$ = temperature of the electrolyte.

NOTE — This value of specific gravity is for test purposes only. For normal use, the service specific gravity recommended by the manufacturer shall be maintained.

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*General requirements and methods of tests for lead-acid storage batteries.

**7.5 First Charge** — The cell or battery, if received in the dry uncharged condition shall be filled with the electrolyte and charged in accordance with the manufacturer's instructions.

**7.6 Visual Examination** — All components shall be visually examined to check conformity with the relevant requirements of **3.1** to **3.8** and **6.**

**7.7 Checking of Dimensions** — The dimensions of cell terminal posts and fittings shall be checked for conformity with the requirements of **3.9** and **5.**

**7.8 Test for Materials and Components** — The rubber or plastic containers, sealing compound, sulphuric acid and water shall be tested for conformity to various Indian Standards specified under **3.2, 3.4, 3.10** and **3.11** respectively.

**7.9 Air Pressure Test** — The sealing of each cell of the battery shall be checked by compressed air at a pressure equal to 15 cm of water. The volume of the tubes and auxiliary parts in connection with the cell shall not exceed 0·5 litre. The air pressure in the cell 15 seconds after the supply has been disconnected shall be noted.

**7.9.1** *Requirement* — The air pressure shall not fall from 15 cm to below 12 cm of water at the end of 15 seconds.

### 7.10 Test for Capacity

**7.10.1** After standing on open circuit for not less than 2 hours and not more than 12 hours from completion of full charge, the cell shall be discharged as specified in **7.10.2** and **7.10.3**. The specific gravity and level of electrolyte shall be checked after the full charge and adjusted, if necessary.

**7.10.2** The cell shall be discharged through a suitable variable resistance at a constant current $I = 0{\cdot}20\ C5$ A, until the terminal voltage falls to 1·70 V.

**7.10.3** During the discharge, the following values shall be noted at suitable intervals:

a) The terminal voltage of the cell;
b) The discharge current; and
c) The temperature of the electrolyte.

The voltages shall be checked at the following intervals:

a) Every 30 minutes up to 1·90 V per cell;
b) Every 15 minutes thereafter till 1·80 V per cell; and
c) Every 5 minutes thereafter.

**7.10.4** The time in hours from the commencement of discharge until the terminal voltage has fallen to 1·70 V per cell is the duration of discharge ( *a* in the formula ).

**7.10.5** The capacity in ampere-hours at $t$°C is:

$$C_{t^\circ C} = a \times 0{\cdot}20 \ C5$$

where

$a$ = discharge duration in hours,

$t$°C = average value of the initial and final electrolyte temperature, and

$C5$ = manufacturer's rating in Ah.

**7.10.6** The rated capacity is defined at a reference temperature of 30°C. If the average temperature $t$° during the discharge differs from 30°C, the capacity measured shall be corrected to 30°C by using the following formula:

$$C30^\circ C = \frac{C_t}{1 + 0{\cdot}008 \ ( t - 30 )}$$

The figure 0·008 represents the temperature-coefficient of variation of capacity of 0·8 percent per °C.

**7.10.7** *Requirement* — On the first discharge the cell shall give not less than 85 percent of the rated capacity $C5$ and the rated capacity shall be reached in ten discharges subsequent to the initial charge. If as a result of the first test itself the capacity is found to be equal to or above the rated value, it is not necessary to carry out further tests.

# APPENDIX A

( *Clauses* 0.2 *and* 3.5 )

## GUIDELINES ON DESIGN OF BATTERY TRAYS AND LAYOUTS

### A-1. GENERAL

**A-1.1** The design principles described below should be followed whenever possible.

When conflicting requirements arise, the battery maker should assess the probable effects of deviating from these principles and should explain these effects to the customer at the design stage.

These details apply to normal electric delivery vehicles and truck batteries. Batteries working under hazardous or other special conditions may require special consideration.

## A-2. WOOD TRAYS

**A-2.1** When the total weight of the battery excluding wooden tray does not exceed 450 kg, the timber thickness shall be not less than 20 mm for sides, ends and base.

When the total weight of the battery excluding wooden tray exceeds 450 kg, or when the spaces described in **A-2.2** cannot be provided, thicker timber or specially reinforced construction or both may be necessary.

**A-2.2** For each 600 mm of tray length and width, spaces of 15 to 20 mm should be allowed for strengthening tie rods or wood spacers or both. In addition, 3 mm fitting tolerance should be allowed in the length and width of all wood trays.

## A-3. STEEL TANKS

**A-3.1** The thickness of metal in the tank sides, ends and base should be not less than that shown in Table 1.

### TABLE 1 THICKNESS OF STEEL SHEET FOR TANKS

| Gross Weight of Charged Battery | Thickness of Sheet Steel |
|---|---|
| (1) | (2) |
| kg | mm |
| Up to 300 | 3 |
| 301 ,, 600 | 4 |
| 601 ,, above | 5 |

**A-3.2** Welded steel partitions, 3 mm thick, should be provided so that the size of individual compartments does not exceed 510 mm in length of width.

**A-3.3** The space available for insulating packings between the cells and the sides, ends and partitions of the tank should be 6 mm minimum. Between the cells and the base of the tank the space available should be 6 to 10 mm.

**A-3.4** The desirable clearance between the steel tank and any terminal or cable socket is 12 mm minimum.

**A-3.5** Internal weld fillets should not be larger than 6 mm × 45°C and should be avoided by welding externally whenever possible.

**A-3.6** The sides, base and partitions should be flat and square.

**A-3.7** Drainage holes should be provided in the base of the tank and the insulation under the cells should be drilled to correspond. Holes should preferably be 25 mm and not less than 10 mm diameter. They should be positioned under points where four box corners meet and in staggered rows. The holes should be 300 mm to 450 mm apart.

**A-3.8** Holes or slots should be provided in the sides of the tray above the cell boxes to allow adequate ventilation, where trays have sides higher than the height of the cells.

**A-3.9** Steel covers should be robust enough to resist distortion on impact. The underside of the cover should be insulated if the clearance above any cell terminal is less than 40 mm. The preferred clearance is 75 mm.

**A-3.10** Lifting holes should be positioned to provide ample clearance between the lifting hooks and any cell terminal or connector. The lifting holes should be positioned where the least distortion of the sides of the tank will occur when lifting.

## A-4. ARRANGEMENT OF CELLS, CONNECTORS AND TERMINALS

**A-4.1** The intercell connectors should be as short as possible.

**A-4.2** When the nominal voltage between any two adjacent cells exceeds 36 V, it may be advisable to fit a position with an insulating barrier between the adjacent rows. The barriers should project above the cell boxes. When operating conditions are conducive to high surface leakage, it may be advisable to fit insulating barriers when the nominal voltage between adjacent cells is less than 36 V.

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